Undergraduate Catalog of Courses

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Physics and Astronomy

Saint Mary's College of California

PHYSICS AND ASTRONOMY

Physics in this century has become a complex endeavor reflecting many centuries of experimentation and theory. It is an enterprise conducted by men and women who are stimulated by hopes and purposes that are universal: to understand and describe nature in its most elementary form. Physics and astronomy courses train students to carefully observe physical phenomena and to interpret the phenomena using synthesis, mathematical modeling and analysis. These methods represent a way of knowing that is central to the scientific method. The department is dedicated to teaching students with majors in science as well as general science education in the liberal arts tradition.

FACULTY
Jessica C. Kintner, Ph.D., *Professor, Chair*
Ronald P. Olowin, Ph.D., *Professor*
Chris M. Ray, Ph.D., *Professor*
Mari-Anne M. Rosario, Ph.D., *Associate Professor*
John Waddell, M.S., *Associate Professor, Emeritus*
Roy J. Wensley, Ph.D., *Professor*

LEARNING OUTCOMES
Students who graduate with a major in physics will be able to analyze complex and subtle physical phenomena and systems. The successful student will be able to identify the physical and mathematical principles relevant to a system—even principles that are addressed in separate courses and disciplines. Using the principles they identify, students will be able to carry out the necessary analysis and synthesis to model the system accurately, and will be able to effectively communicate their results.

MAJOR REQUIREMENTS

BACHELOR OF SCIENCE
The bachelor in science (B.S.) degree in physics is designed for students who wish to pursue careers or graduate study in scientific and technically intensive fields. The department also offers a degree concentration in astrophysics.

LOWER DIVISION
Physics 1, 2 (lab), **3, 4** (lab), and **60**
Math 27, 38, and **39**

UPPER DIVISION
Physics 102, 105, 110, 115, 125, 181, and three elective upper division physics courses, and **Math 134.**

The concentration in astrophysics requires the three elective courses to be **Physics 170, 173,** and **185.**

BACHELOR OF ARTS
The bachelor of arts (B.A.) degree provides students the flexibility to pursue additional academic interests, such as undertaking a minor, completing courses for medical school, or preparing for law school.

LOWER DIVISION
Physics 1, 2 (lab**), 3, 4 (**lab**),** and **60**
Math 27, 38, and **39**

UPPER DIVISION
Physics 102, 105, 110, 115, 125, 181, and two elective upper division physics courses.

MINOR REQUIREMENTS

Physics 1, 2 (lab), **3, 4** (lab), and **60; Mathematics 27, 38,** and **39.** And three elective upper-division physics courses.

PREREQUISITE GRADE
Any course listed in this department with a prerequisite assumes a grade of C– or better in the prerequisite course.

COURSES

LOWER DIVISION

1 Introduction to Physics I
This course is the first in a two-part sequence and is designed for students majoring in physics, chemistry and mathematics, and for students preparing for an engineering program. The sequence introduces students to topics in Newtonian mechanics, vibrations and oscillations, waves and sound, thermodynamics, electricity, magnetism, simple circuits and optics (geometrical and wave). Four lectures weekly. Concurrent enrollment in **Physics 2 (lab)** is required. *Prerequisite:* **Math 27** *(may be taken concurrently). This course satisfies the Scientific Understanding requirement of the Core Curriculum.*

2 Introduction to Physics I Laboratory (.25)
Students gain hands-on experience with the topics discussed in **Physics I.** Additionally, students are introduced to methods of experimentation in physics including good measurement techniques, simple data analysis and scientific writing. Concurrent enrollment in **Physics I** is required. Laboratory fee required.

3 Introduction to Physics II
Continuation of **Physics I.** Four lectures weekly. Concurrent enrollment in **Physics 4 (lab)** is required. *Prerequisites:* **Physics I** *and* **Math 38** *(may be taken concurrently).*

4 Introduction to Physics II Laboratory (.25)
Students explore the concepts of **Physics 3** in a laboratory setting. Concurrent enrollment in **Physics 3** is required. Laboratory fee required.

10 General Physics I
This course is the first in a two-part sequence. The sequence introduces the student to the conceptual framework of physics, and the phenomenology of mechanics, fluids, waves, thermal physics, electricity, magnetism, optics and modern physics. In comparison with the Introduction to Physics sequence this course chooses breadth over depth, and is expected to be more suited to needs of life science students. Three lecture hours and one lab per week. Laboratory fee required. *Prerequisite:* **Math 27.**

11 General Physics II
Continuation of **Physics 10.** Three lecture hours and one lab per week. Laboratory fee required. *Prerequisite:* **Physics 10.**

40 Revolutions in Science
This course is intended to introduce the methods and ideas of science. Students gain an appreciation for the scientific "way of knowing" by learning how phenomena in nature are observed and catalogued, and how general principles are deduced from observations. Concurrent enrollment in **Physics 41** is required. *This course satisfies the Scientific Understanding requirement of the Core Curriculum.*

41 Revolutions in Science Laboratory
Laboratory to accompany **Physics 40.** Must be taken concurrently with that course. Meets every other week. Laboratory fee required.

60 Modern Physics
The discoveries and methods of physics developed in the 20th century will be studied. Relativity, statistical physics, and quantum mechanics are the main topics. Applications including molecular, condensed matter, nuclear and particle physics are stressed. *Prerequisite:* **Physics 3.**

90 Introduction to Astronomy
This introductory course presents a comprehensive and balanced view of what is known about the heavens. Aimed at the non-specialist, the course gives a description of astronomical phenomena using the laws of physics. The course treats many standard topics including planets, stars and galaxies to more esoteric questions concerning the origin of the universe and the search for extraterrestrial intelligence. *Prerequisites: One year each of high school algebra I, II and geometry. Concurrent enrollment in* **Physics 91** *is required. This course satisfies the Scientific Understanding requirement of the Core Curriculum.*

91 Astronomy Laboratory (.25)
Laboratory to accompany **Physics 90.** Exercises include experiments in a laboratory setting, observations using the campus observatory and telescopes, and field trips to local observatories and/or planetariums. Laboratory fee required.

UPPER DIVISION

Physics 3 *and* **Math 39** *are prerequisites for all upper-division physics courses.*

102 Computational Physics
This course will be an introduction to the use of computational techniques to understand physical systems that are unapproachable via analytical methods. The class will also be an introduction to effective programing in Matlab. Topics will include applications of numerical integration, numerical solutions to transcendental equations, ordinary differential equations and partial differential equations, and the use of Fourier analysis.

105 Analytical Mechanics
This course covers the principles of particle dynamics. Topics include rigid body dynamics, Lagrange's equations, Hamilton's principle, wave propagation, and normal modes of vibration in oscillating systems.

110 Electricity and Magnetism
Electrical and magnetic concepts are studied using static and dynamical field concepts. Maxwell's equations are emphasized. Topics include electrostatics, electrodynamics, magnetism and electromagnetic waves.

115 Thermal and Statistical Physics
This course covers the laws of thermodynamics and statistical physics. Topics include temperature, work, heat transfer, entropy, phase transitions, Maxwell's relations, the kinetic theory of gases, partition functions and particle statistics.

125 Quantum Mechanics
Introduction to the theoretical foundations of quantum theory. Using the Schrödinger and Heisenberg formulations of the harmonic oscillator, the hydrogen atom, the theory of quantized angular momentum and scattering are studied. The concepts of Hilbert space, operators, commutation relations and the Heisenberg uncertainty principle are included. *Prerequisites:* **Mathematics 134** *and* **Physics 60.**

140 Special Topics in Advanced Physics
Focus on variable topics such as particle physics, solid state physics, optics or numerical methods of physics. May be repeated for credit as content varies.

170 Astrophysics
A study of the internal constitution of stars and stellar systems from the point of view of atomic and nuclear physics. The basic equations of Saha and Boltzman are used to solve the appearance of observed stellar spectra and the differential equations of continuity and state to interpret the physical properties of stellar structures.

173 Cosmology
Using a historical approach, this course studies how humankind has come to understand the origin and structure of the universe. The course begins with studies of ancient cosmologies, such as those from Egypt, Ancient Greece, Pre-Columbian America and the Orient. This sets the stage for the revolution in understanding brought about by Copernicus, Kepler, Galileo and Newton. This fascinating journey is carried through to the present by studying modern astrophysics including topics such as relativity, black holes, stellar evolution and the Big Bang.

180 Experiments in Modern Physics
Students discuss and perform the experiments that demonstrate and investigate the principles of 20th-century physics. Experimental topics include the photoelectric effect, the Franck-Hertz experiment, x-ray diffraction, solid state materials, nuclear spectroscopy and holography. This course meets for two laboratory sessions and one lecture session each week. Laboratory fee required. *Prerequisite:* **Physics 60.**

181 Electronics and Instrumentation
Students study the properties of various circuit components and use them in scientific applications. Topics include linear DC and AC circuits, diodes, transistors, operational amplifiers and photoelectronic devices. Meets for two laboratory sessions and one lecture session each week. Laboratory fee required. *This course satisfies the Writing in the Disciplines requirement of the Core Curriculum.*

185 Observational Astronomy and Astrophysics
A laboratory course based on the attempt to model, simulate and interpret observational data derived from astronomical observations. Included are interpretations of stellar photographs and spectra, measurements of various stellar parameters and quantities that give rise to our understanding of stars as physical systems. Laboratory fee required.

196 Senior Essay (.25)
Independent study of a topic beyond the common course content. Open only to majors in the spring term of their junior year or fall term of their senior year. The essay is evaluated by a committee consisting of the faculty supervisor and two other faculty chosen in consultation with the student. *Permission of the department chair is required.*

197 Special Study
Independent study or research of topics not covered in listed courses. *Permission of the department chair is required.*

199 Special Study — Honors
Independent study or research for majors with at least a B average in physics. *Permission of the department chair is required.*